



# AEROSOL MASS SPECTROMETER MEASUREMENTS ON BOARD THE DOE G1 DURING THE NEW ENGLAND AIR QUALITY STUDY 2002

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*Double Diffuser Cone Gas/Aerosol  
Inlet System - Fred Brechtel*



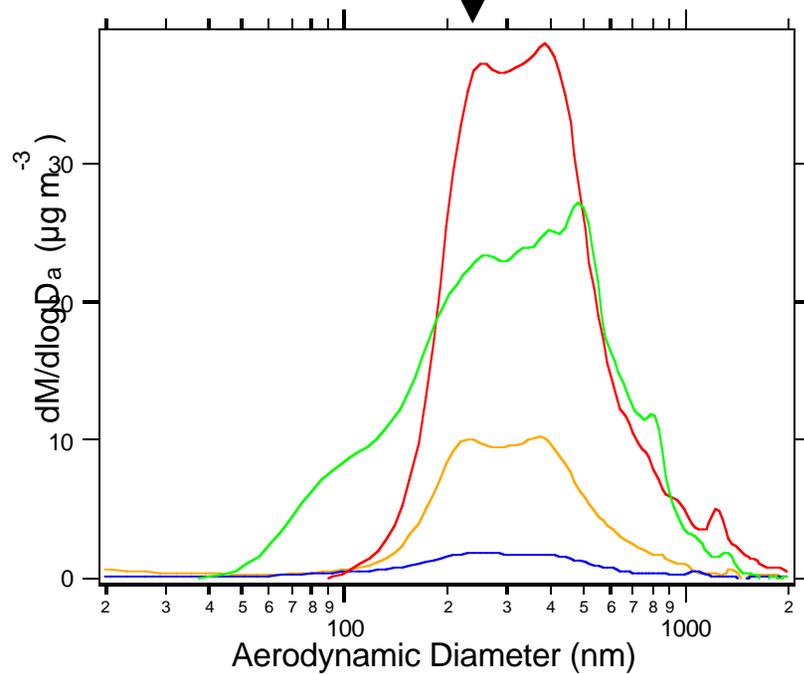
*AMS Package*

# Real Time Chemical and Physical Composition of Aerosols

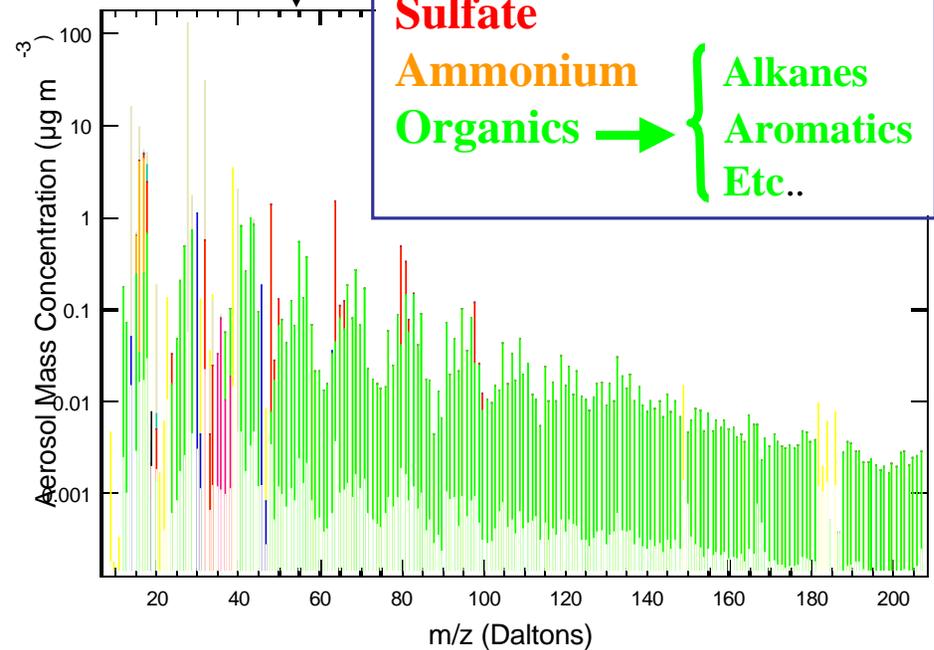
## Aerosol Sampling

*Sampling frequency 30 sec.  
Real-time measurement.*

AMS



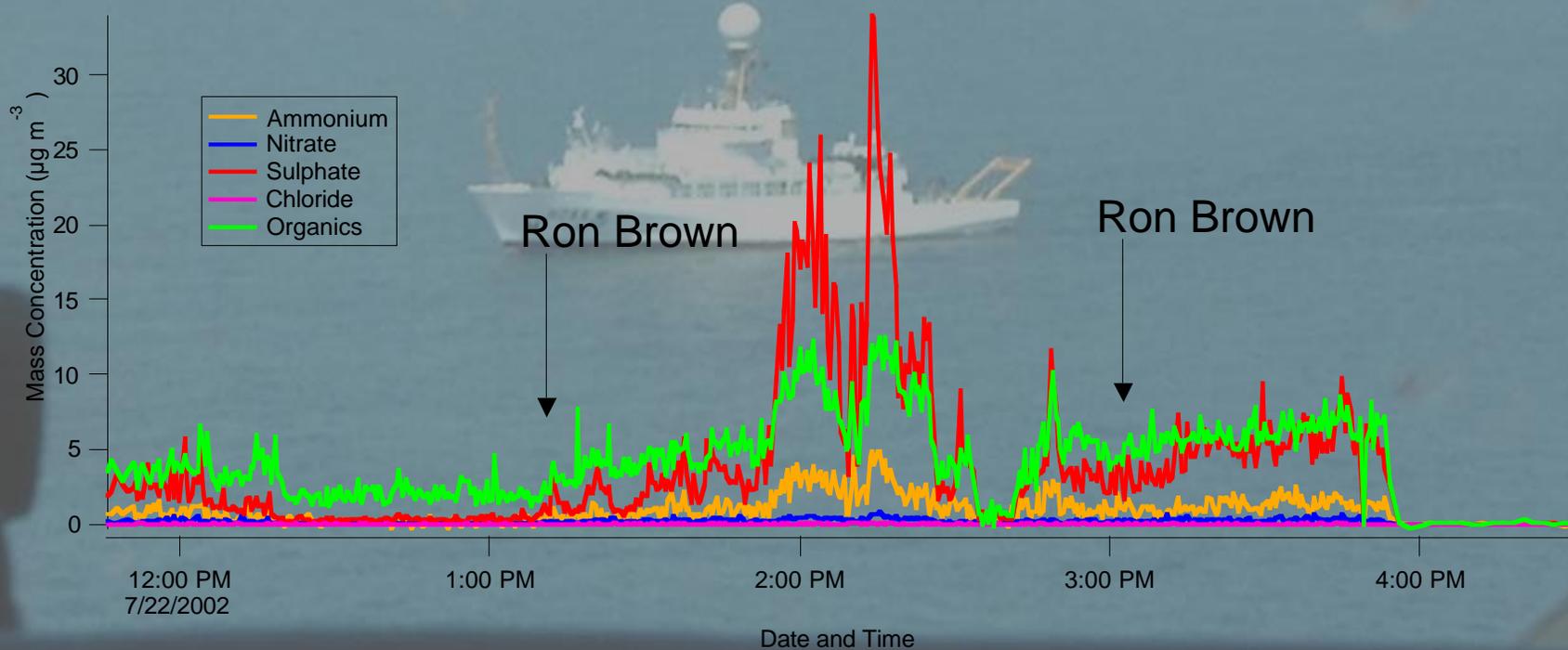
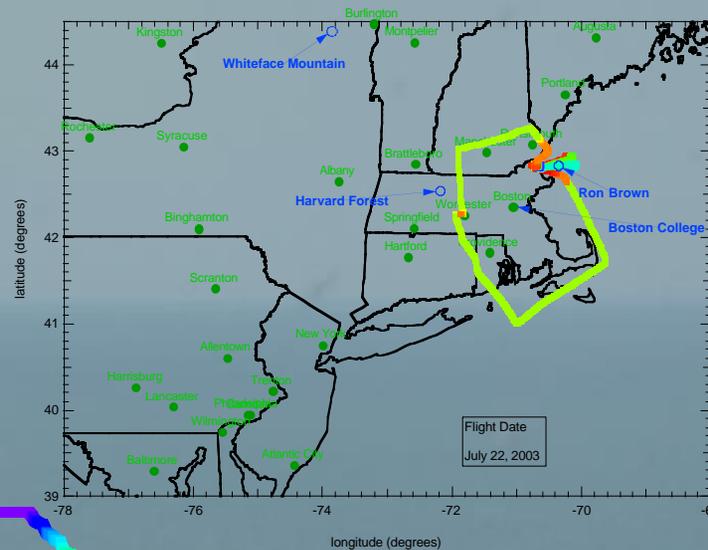
**Mass distribution**



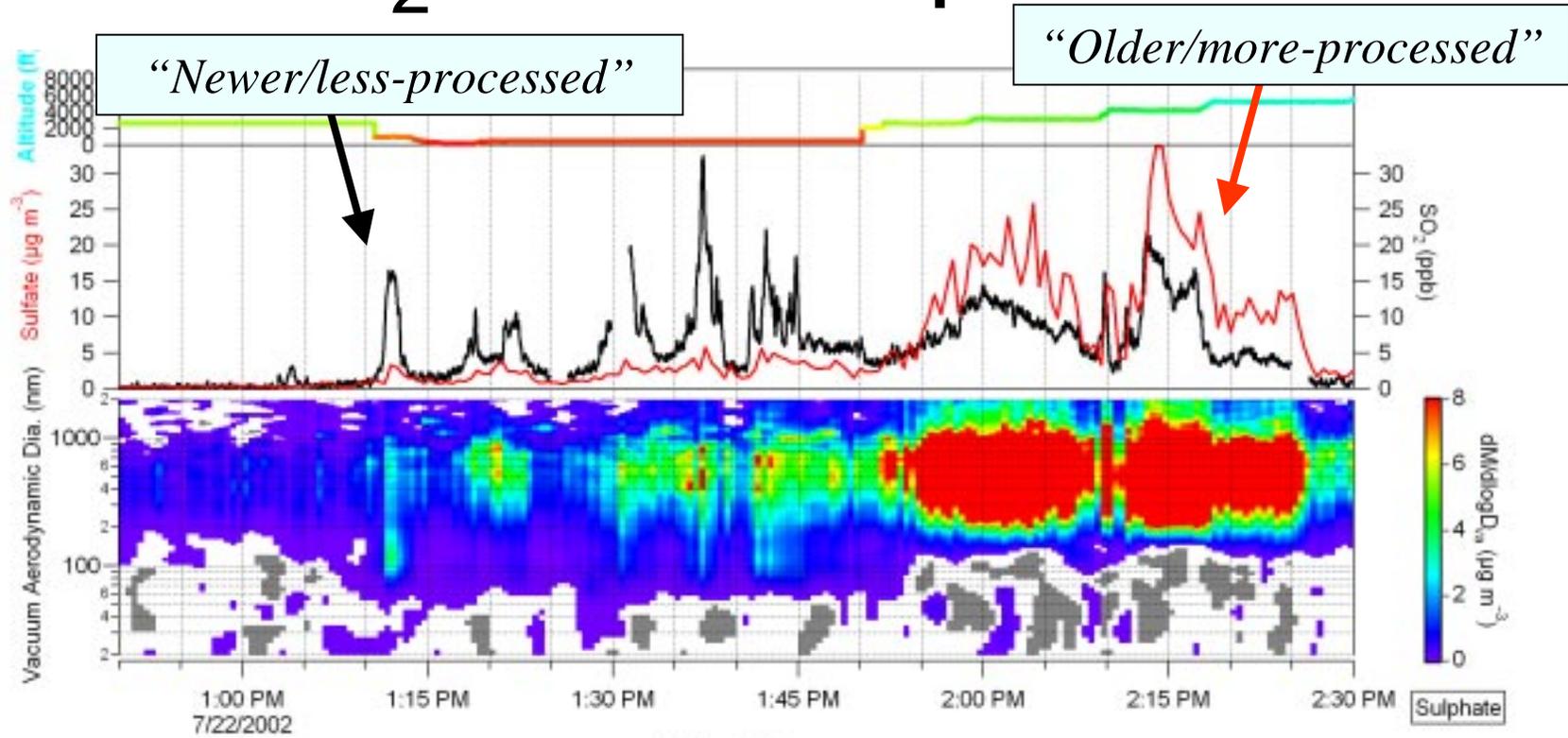
**Chemical composition**



# Vertical Profile: Transects over the NOAA Ship *Ron Brown* Flight Track on July 22



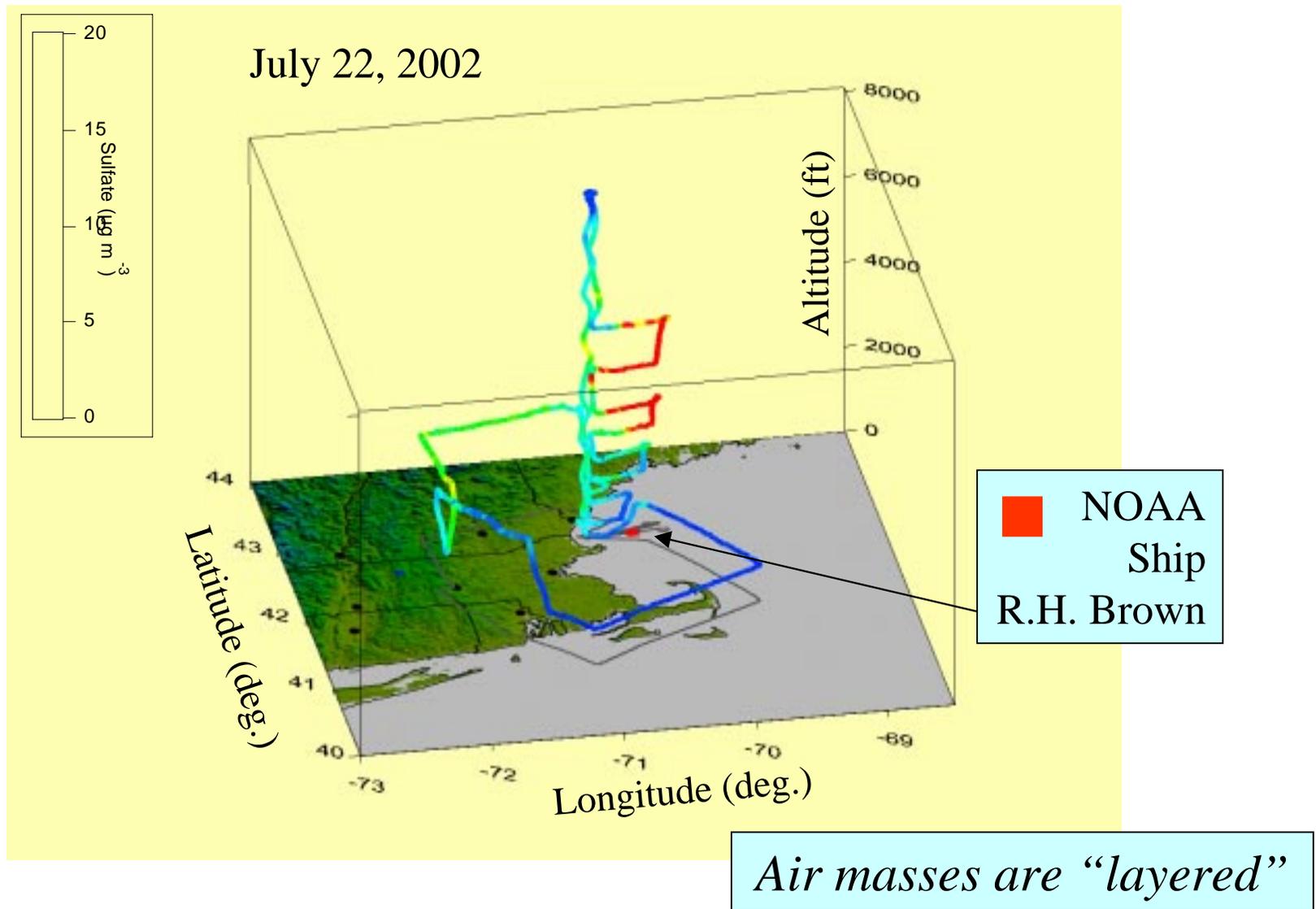
# SO<sub>2</sub> – Sulfate plumes



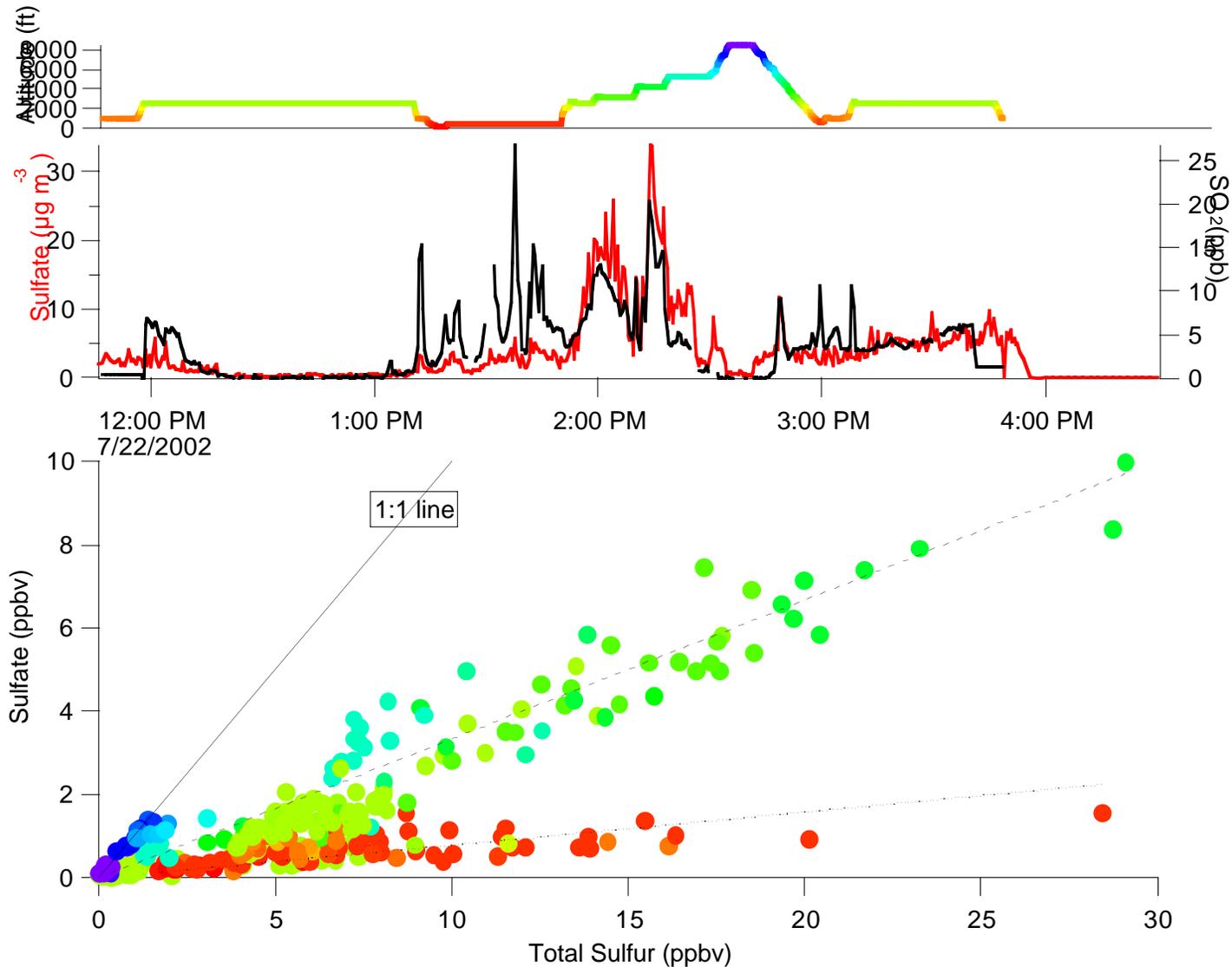
- Shape of Size Distributions Consistent with "Extent of Processing"

# G1 Flight Track

## *Horizontal Transects over NOAA Ron Brown*



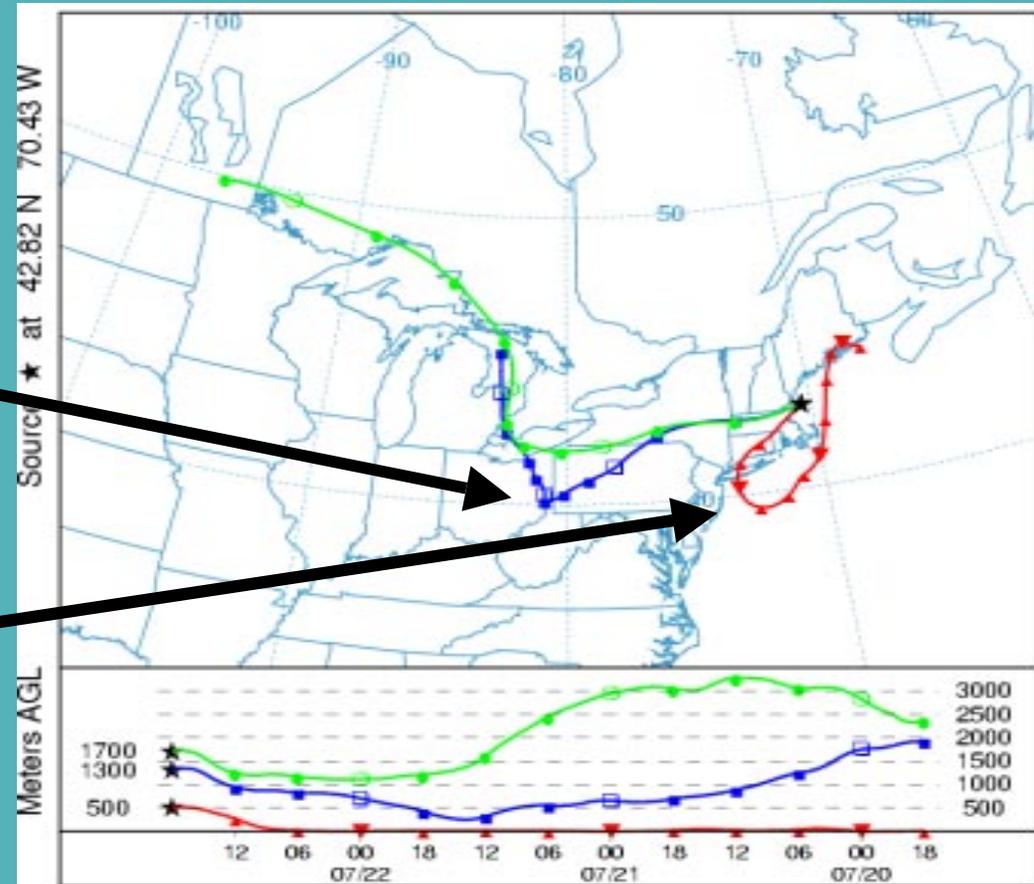
# Stratification of sulfate “aging”



# What Is the Origin of the Sulfate Plume?

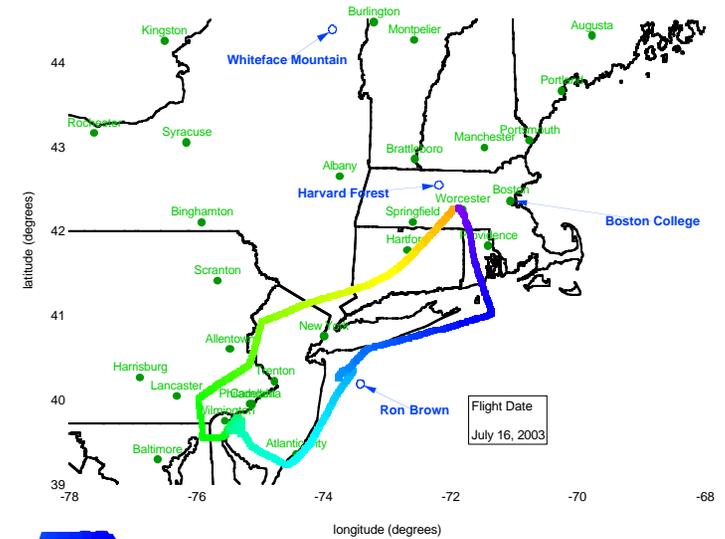
*Back trajectory shows high sulfate air mass at 1.3 km originating from Ohio Valley*

*Back trajectory shows high SO<sub>2</sub> air mass at 0.5 km originating within New England Region*



# Northeastern Corridor Emissions profile: Power plant and city sources.

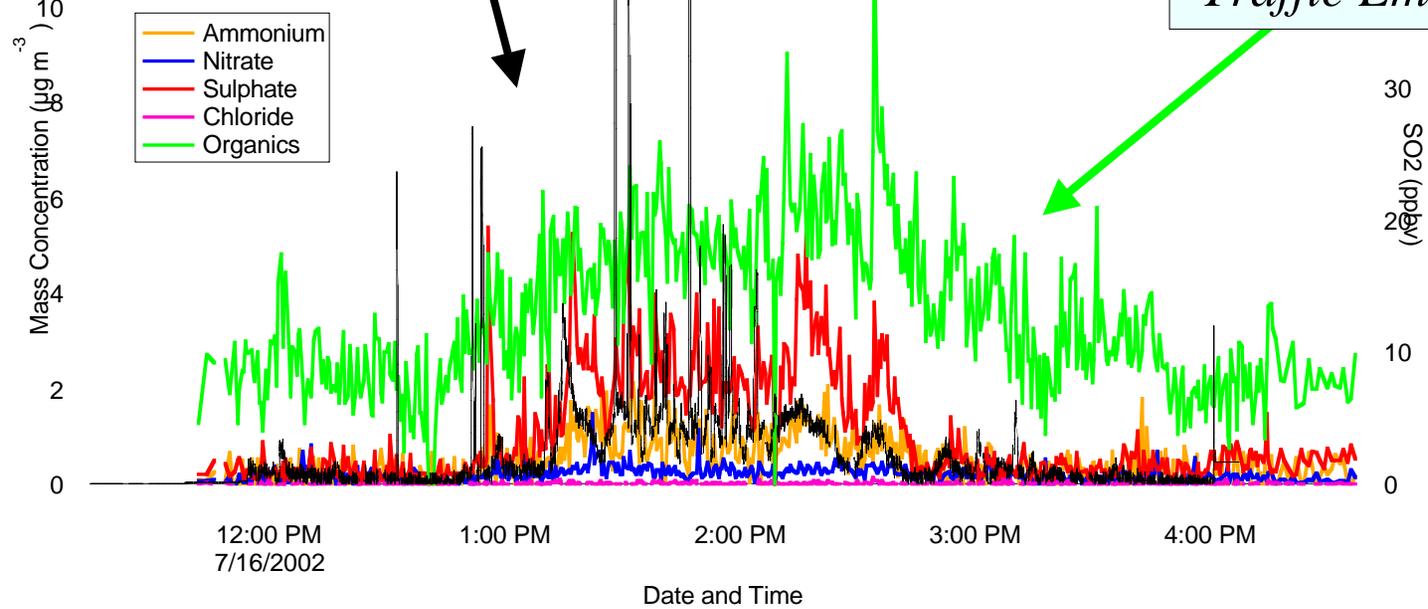
Flight Track on July 16



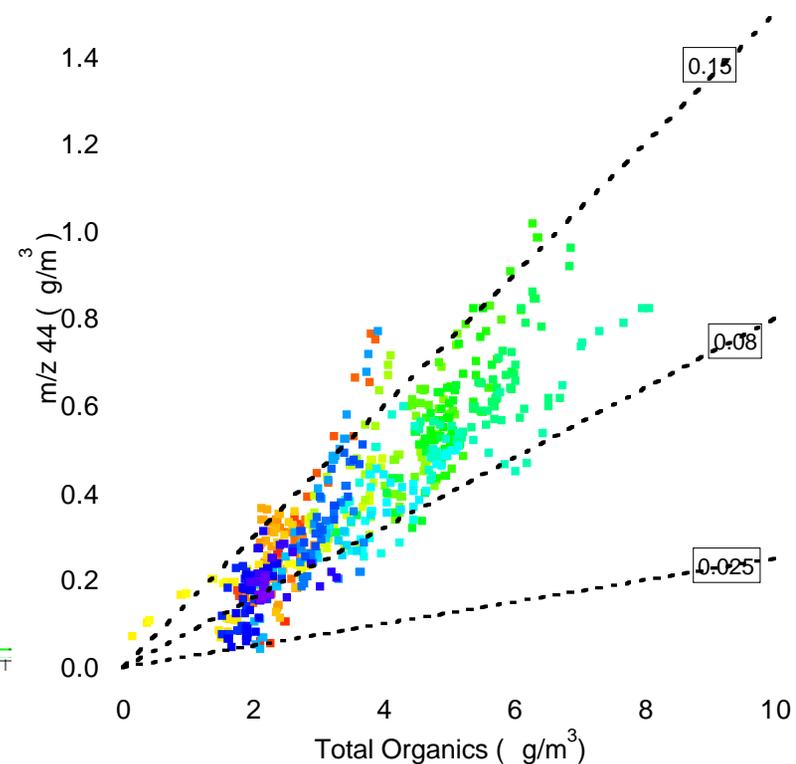
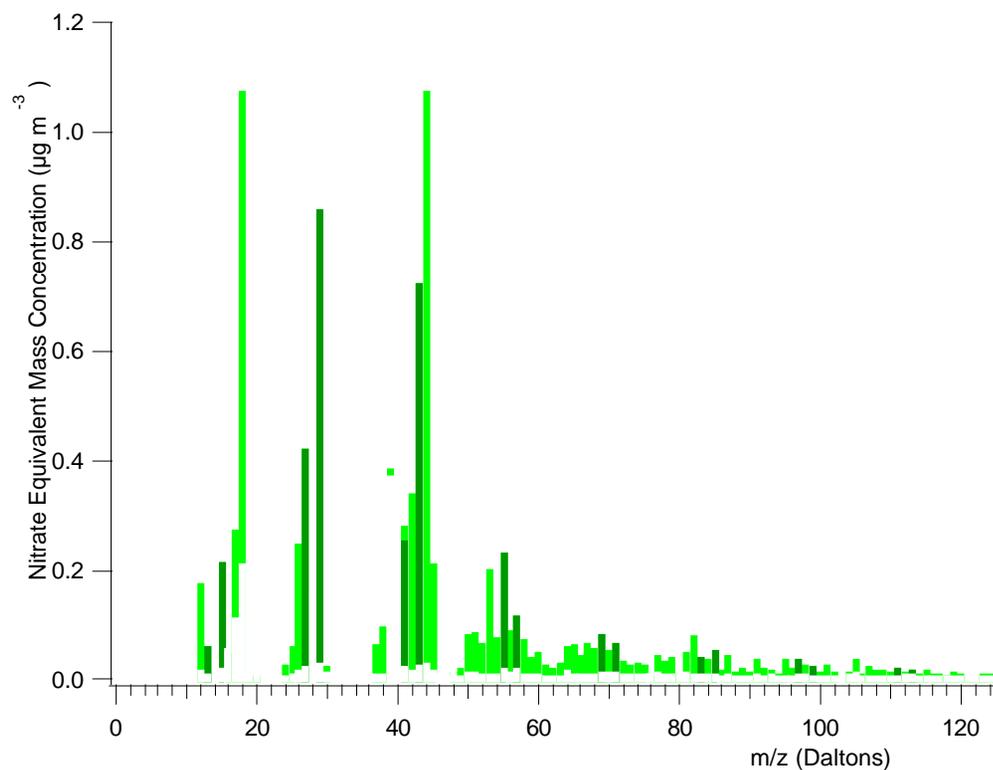
*Power Plant Emissions?*



*Traffic Emissions?*

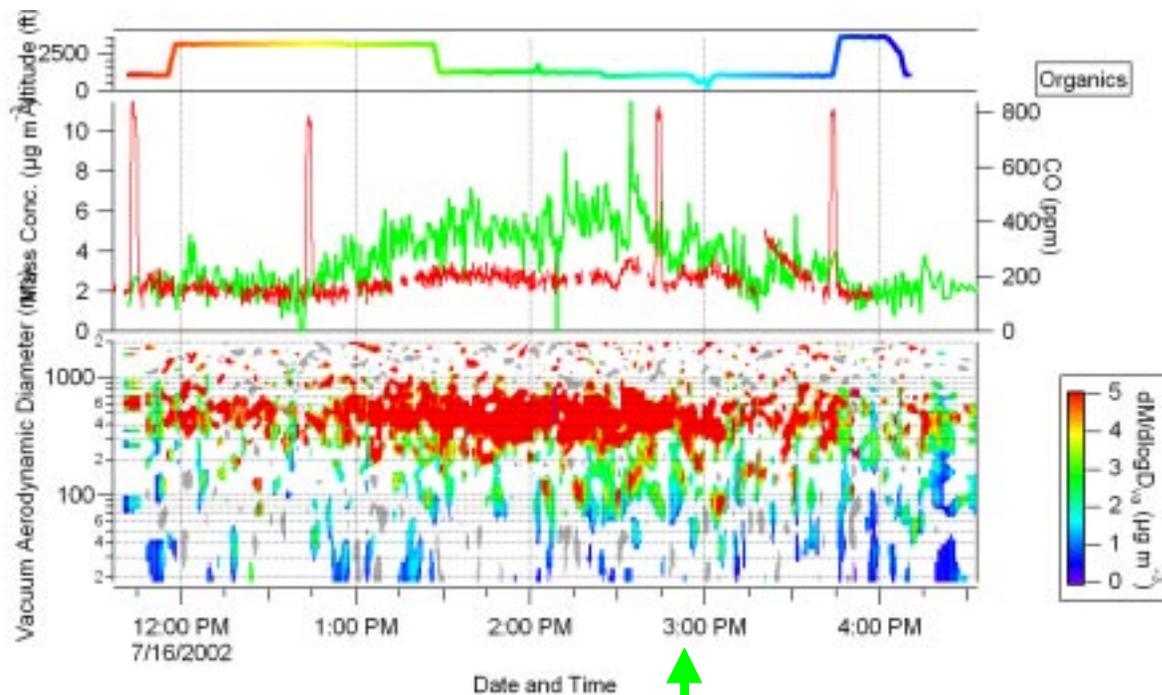


# Organic component of aerosols



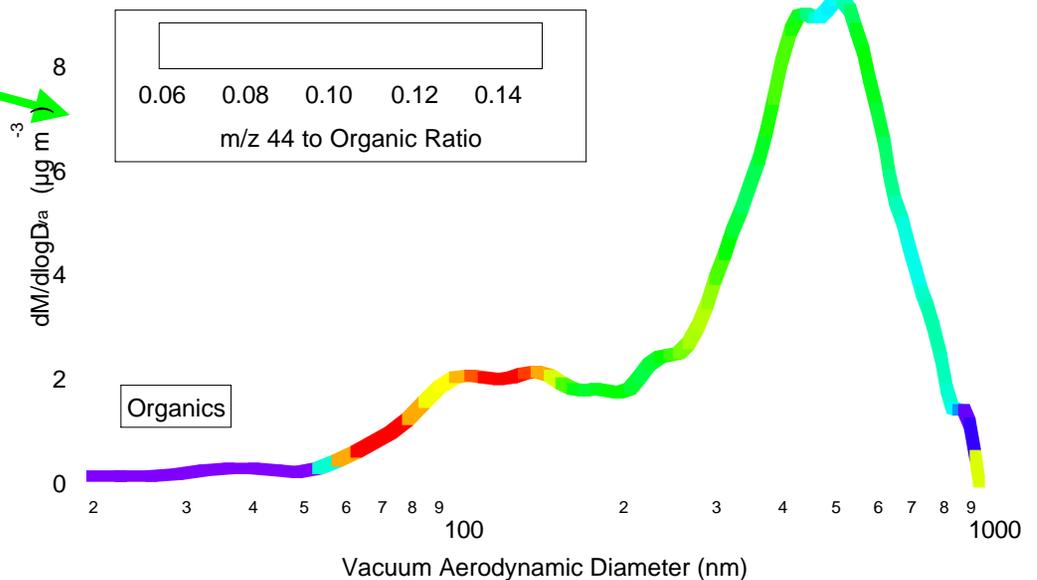
- Highly oxidized organic components
- No significant stratification of the oxidation “age” of the organics.

# Observations of Primary Organic Particles



*Traffic Emissions*

- Evidence of primary organic particles in small particle mode.
- Small mode typical of primary traffic exhaust emissions



# Summary

- The nonrefractory submicron aerosol mass loadings were composed primarily of organics and sulfate species. Mass loadings were  $<45 \text{ g/m}^3$ .
- Air masses passing through the NE region at a constant altitude were influenced by emissions ( $\text{SO}_2$  and organics) within the coastal area.
- Air masses were found to be vertically layered. Back trajectories indicate that the polluted layers (July 22<sup>nd</sup>) were transported from the Ohio River Valley region (outside of the Northeastern region).
- The oxidative 'age' of **sulfate aerosols** in air masses were tracked by the  $\text{SO}_4:\text{S}_{\text{total}}$  ratio, back trajectories, and the size and growth of sulfate particles. These markers illustrate the influence of local sources in the lower atmosphere and the influx of aerosols from sources outside of the region at altitude.
  - Air masses with relatively high  $\text{SO}_2$  and low sulfate were observed to contain bimodal sulfate size distributions: small growth mode (from a nucleation event) and accumulation mode. In contrast, air masses with relatively low  $\text{SO}_2$  and high particulate sulfate were observed to contain only accumulation mode sulfate particles.
  - The sulfate to total sulfur ratio increases with altitude, indicating that higher air masses contained 'older', more processed particles.
- The **organic components of the aerosol** appear highly oxidized and, for the most part, independent of the air mass stratification and/or 'age' of the sulfate component.
- Observations of primary "traffic" emissions at lower altitudes down wind of city sources highlight organic emissions from the NE region.

# Acknowledgements

## BNL Team

*Larry Klineman  
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Gunnar Sennum*

## PNNL Team

*John Hubbe  
Carl Berkowitz  
Victor Morris  
John Schmelzer*

## Pilot

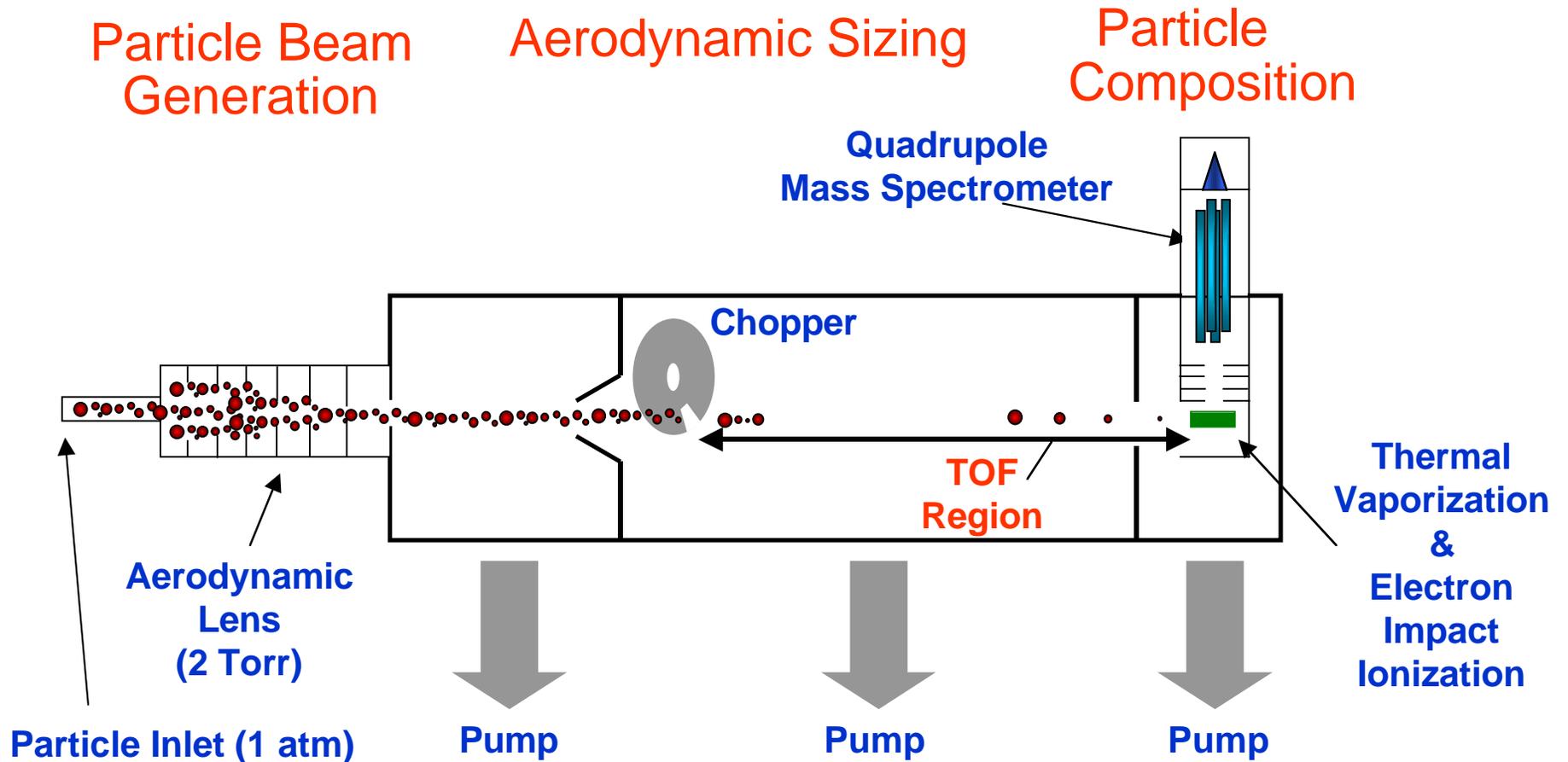
*Bob Hannigan*

## *Funding*

*DOE SBIR  
NSF STTR  
ONR SBIR*

Extra Slides

# Aerosol Mass Spectrometer (AMS)



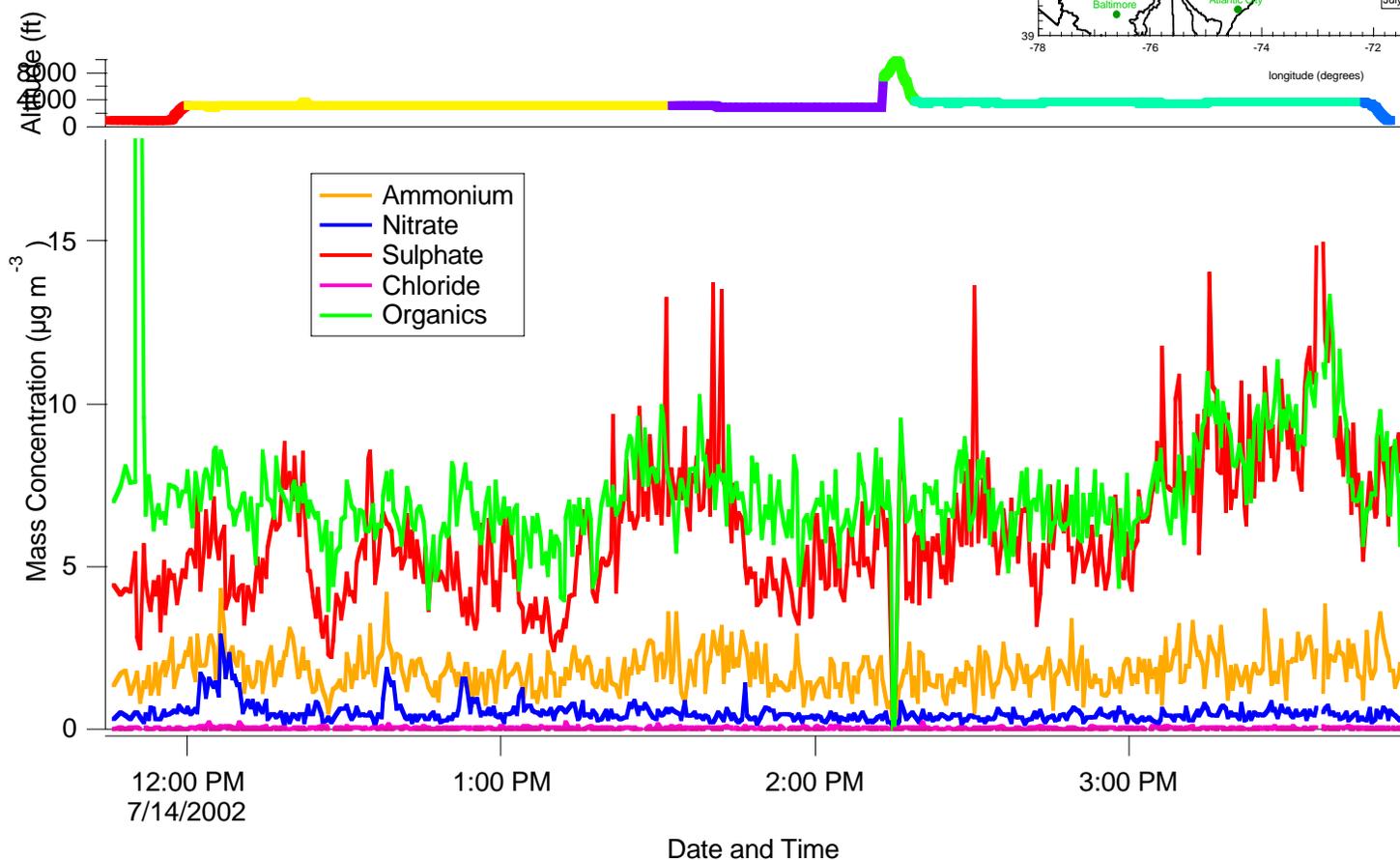
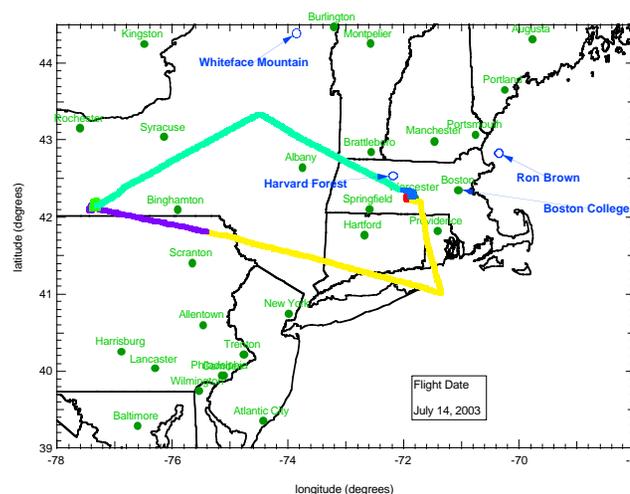
**100% transmission (40-600 nm), aerodynamic sizing, linear mass signal.**

Development of an Aerosol Mass Spectrometer for Size and Composition Analysis of Submicron Particles.

*Jayne et al., Aerosol Science and Technology 33:1-2(49-70), 2000.*

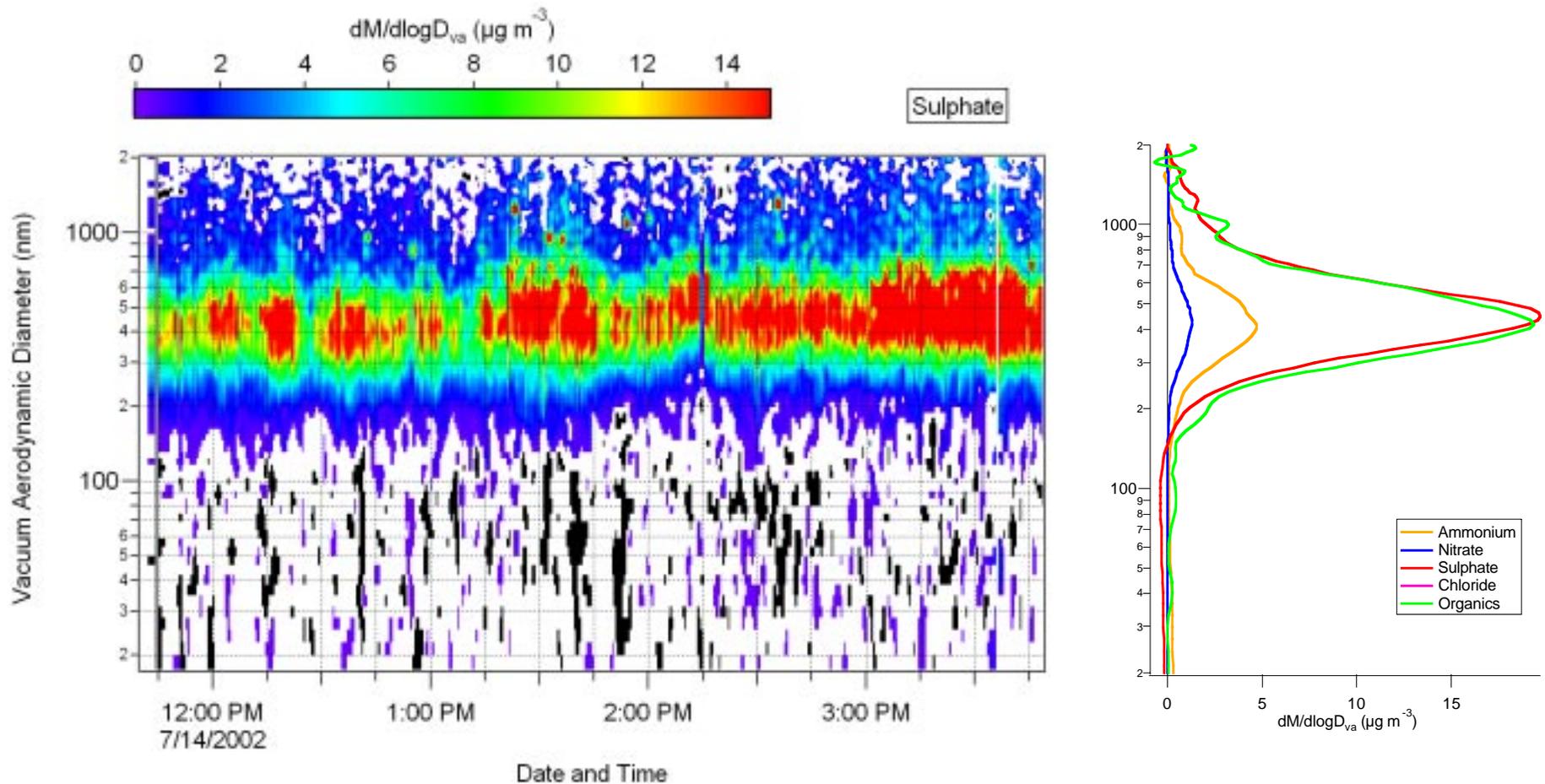
# Constant altitude profile: Down wind/up wind of coastal sources.

Flight Track on July 14



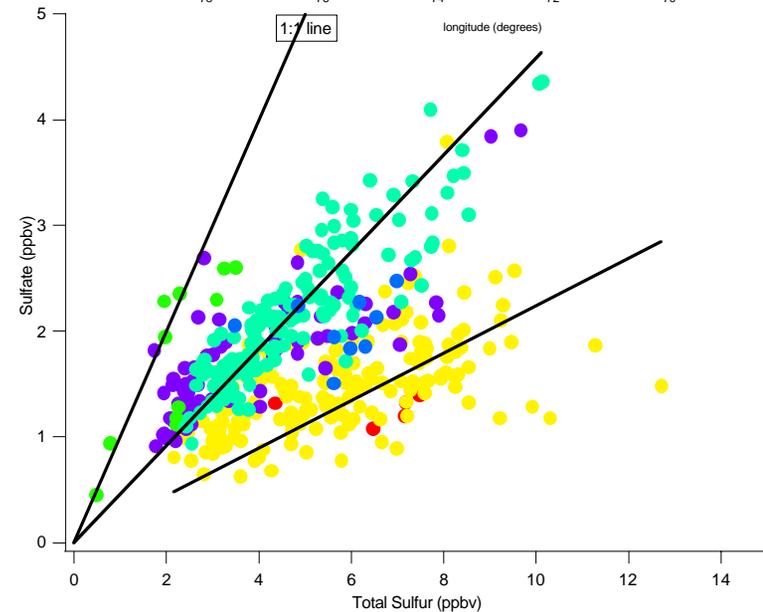
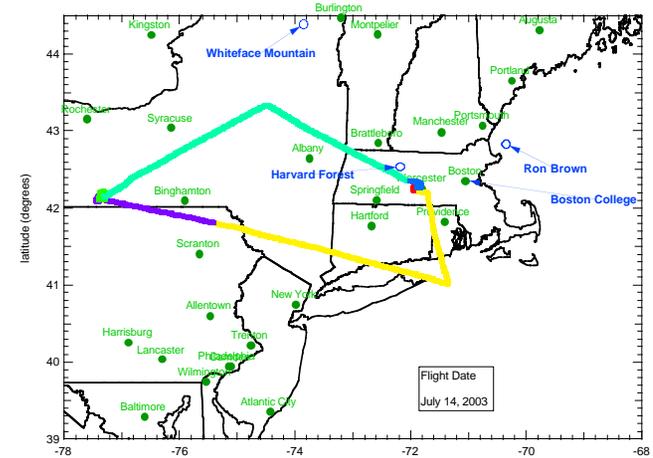
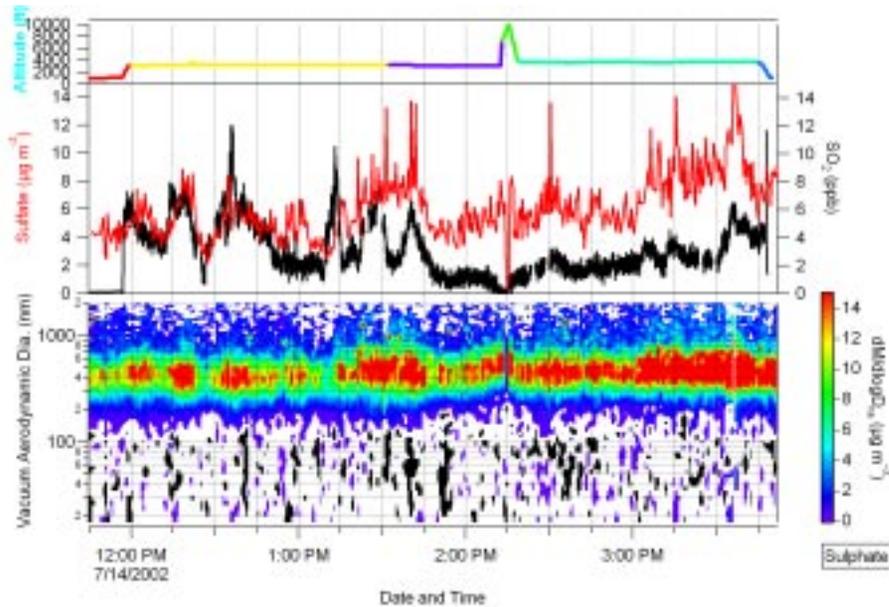
• Aerosol composition is dominated by sulfates and organics

# Chemically-resolved size distributions



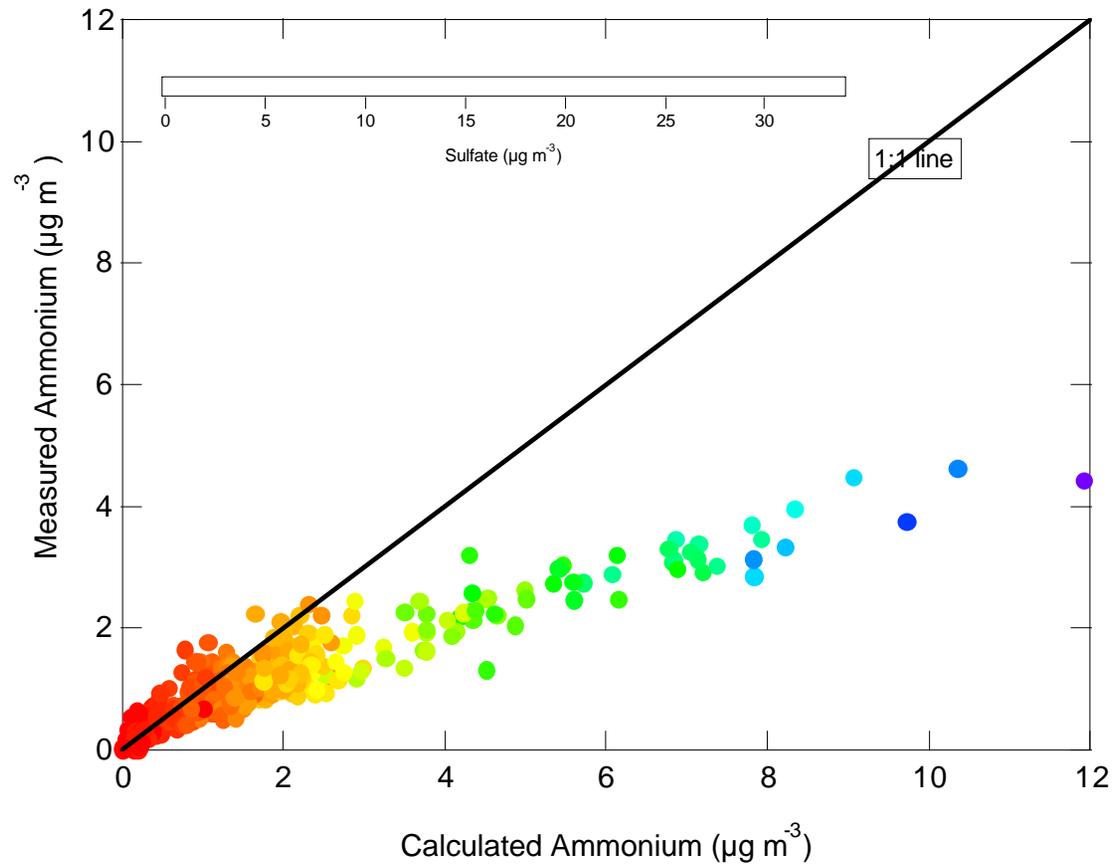
- Apparent internally mixed accumulation mode aerosol particles.

# Local sources of sulfur emissions



- Sulfate aerosol up wind and down wind of costal sources exhibit different sulfate-to-total sulfur ratios
- Evidence that  $\text{SO}_2$  is mixing up from local sources on the eastern seaboard. High levels of background particulate mass on this day may be inhibiting new particle production.

# Degree of Sulfate Neutralization



- The degree of sulfate neutralization is sulfate mass loading dependent, suggesting that ammonia is the limiting factor.

# Morning Traffic Events are “Fresh” Organic Compounds (Mainly Hydrocarbons)

